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Preliminary Post-Cranial Metric Analysis Of Mammoths From The Hot Springs Mammoth Site, South Dakota

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PRELIMINARY POST-CRANIAL METRIC ANALYSIS OF MAMMOTHS FROM THE HOT SPRINGS MAMMOTH SITE, SOUTH DAKOTA

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Salvage investigations of a Karst depression containing more than nine Late Pleistocene mammoth were conducted during approximately twenty field days in the summers of 1974 and 1975. The deposit contains a local death assemblage of a mammoth population. A post-cranial metric analysis has been conducted on the fossil elephant remains.

† † †

INTRODUCTION

Construction work on a housing development on the southern edge of Hot Springs, South Dakota during the summer of 1974 uncovered teeth, tusks, skulls, and a variety of post-cranial skeletal remains of mammoth. The mammoth bones as exposed were concentrated in two separate areas (Areas A and B) of a sediment-filled, Karst depression (Fig. 1), currently a hilltop. The faunal remains seem to lie peripheral to the entire edge of the deposit. The depression, roughly circular in shape, was developed in the Spearfish Formation (a red shale of Triassic age) as a result of dissolution in the underlying Minnekahta Limestone of Permian age. The collapsed sinkhole was later filled with sand, silt, and clay of Late Pleistocene age. Bank caving is noted in the eastern portion of this area, with blocks of Spearfish material compressing and contorting the sand. These were apparently capable of fluid movement, suggestive of subaqueous conditions. The model proposes a Karst depression containing a standing body of water which received sediments and served as a watering location for Late Pleistocene fauna (Agenbroad and Jones, 1975). If the mammoth did come into the sinkhole for water, they probably could not scale the slippery Spearfish shale to get out.

Here we have a local death assemblage (thanatocenosis) of mammoth and associated fauna. The associated animals consist of peccary *(Platygonus)*, bear *(Ursus arctos)*, coyote *(Canis latrans)*, camel *(Camelops)*, rodents and an unidentified raptorial bird. An estimated age of +20,000 years has been postulated on geologic evidence for the site. A collagen sample has been submitted to the laboratory for a radiocarbon date, but is not currently available.

METHODOLOGY

Excavation of the site followed standard archaeological and paleontological techniques as applied at the following sites: Murray Springs, Lehner Ranch, Boney Springs, and Hudson-Meng. Bones were mapped *in situ*, both vertically and horizontally, as encountered in the fill. Horizontal provinence was done with a string grid and transferred to metric graph paper. A vertical datum gave levels on individual bones. A level was taken on the central portion of the bone except when abnormally inclined.

Excavation centered in Area B, the edge of the proposed alleyway, in the approximately 20 days of field work during the two seasons. Remains from this area were mapped, field numbered, removed, and taken to the laboratory for further stabilization, reconstruction, and identification. The remains from Area A were left *in situ* after excavation, for subsequent development of the site.

PURPOSE

Due to the value of post-cranial metric studies on bison at the Hudson-Meng site (Agenbroad, 1977), Casper site (Frison, 1974) and others, we felt a similar analysis would aid future studies in comparisons of mammoth populations. A search of the literature (Saunders, 1970; Maglio, 1973; Osborn, 1942; Falconer, 1863; Barbour, 1925) revealed few measurements taken on post-cranial material, and no standardized measurements for an extensive study of post-cranial metrics have been published. Other than Osborn's (1942) figure of Standardized Skeletal measurements—which is minimal—no other data have diagrams specifying the measurements taken for mammoth have been found. Collections at the Smithsonian Institution and the American Museum of Natural History also fail to yield any comparative data published on the post-cranial metrics of mammoth. We felt our

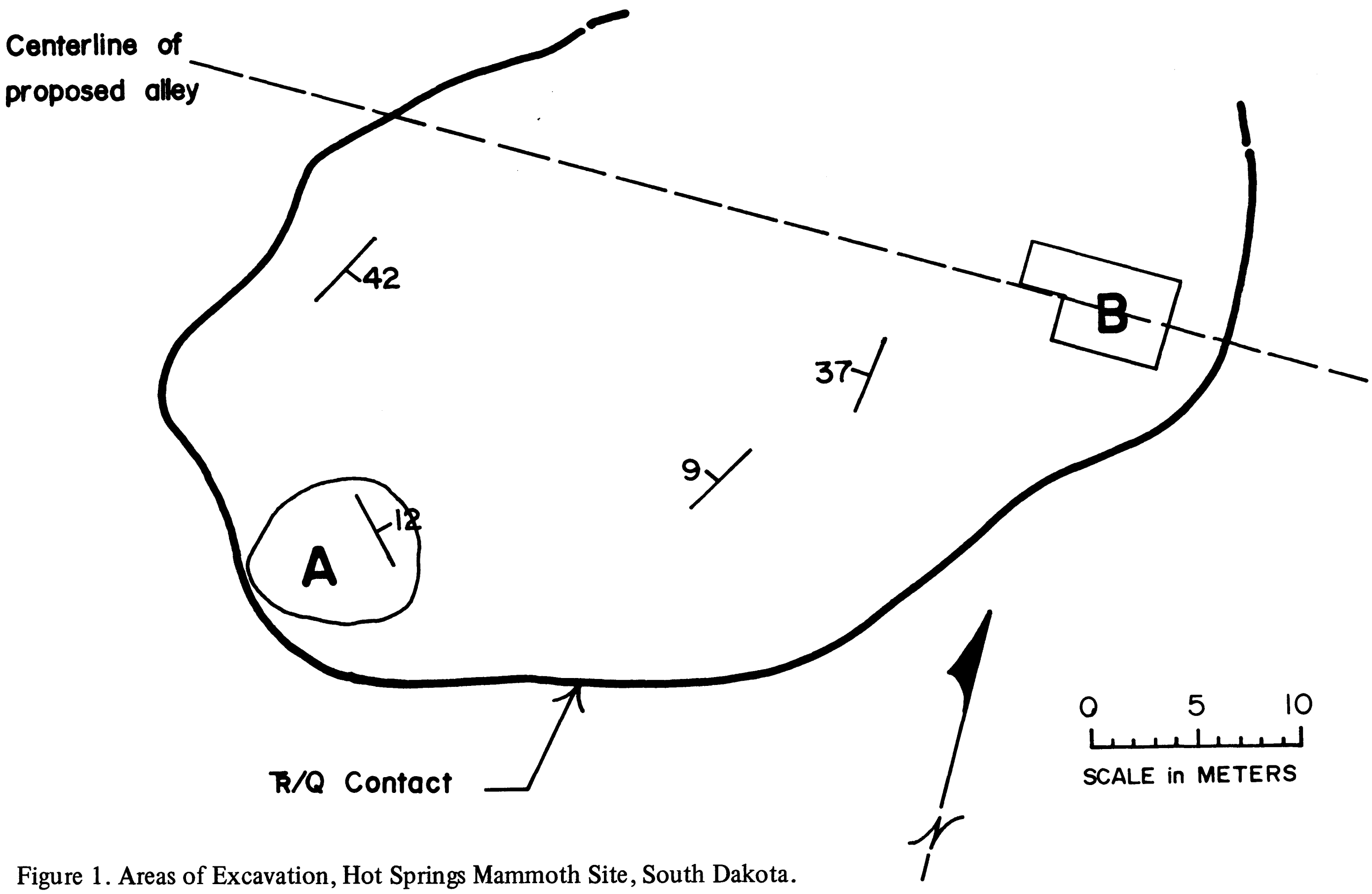

Figure 1. Areas of Excavation, Hot Springs Mammoth Site, South Dakota.

contribution from a thanatocenosis of mammoth would aid the paleontologist and archaeologist in comparative studies when encountering mammoth remains in the field. With additional work, this area may also be of use when determining species when remains are absent of crania or teeth.

RESULTS

Speciation was a primary concern of this study. Much of the published data concerning speciation provided measurements for the skull only. Since none of the four skulls taken from the site was useable for speciation—one remains *in situ*, the discovery skull was demolished by a bulldozer, one was fragmentary, and one is currently in a field cast—speciation was done using teeth, which are the next most frequently described element. Cooke (1960) devised a graph relating the Index of Hyposodonty (100 Ht./Wd.) to the Length-Lamella ratio. Saunders (1970) applied these data to second and third molars from Arizona mammoth, as I did with the first molars, which are most prevalent from our site (Fig. 2). Plotting these values, we arrived at the species *Mammuthus columbi.*, coinciding with our first estimation. Further verification of species will result when a skull is made available. Because of the many discrepancies pointed out by Morrison-Scott (1947), ridge-plate formulas were not used in determination of the species.

Using the method devised by Laws (1966), further study of the teeth resulted in approximating the age of the mammoth at the time of their death. According to their age groupings, we may have one kinship unit, which came to water at this locality and died, the bones of which then became incorporated into the sediments. If not a kinship group, at least we have a thanatocenosis representing a local mammoth population.

To date, we have 267 specimens representing at least nine mammoth. Vertebrae are the most abundant, excluding ribs. The vertebrae consist of 6 incomplete cervicals, including one partial axis; 14 incomplete and complete thoracic; 23 lumbar, incomplete and complete; 2 incomplete sacra; and 5 incomplete and complete caudals. Other specimens include: 4 incomplete and complete crania; 1 incomplete hyoid; 9 complete and incomplete mandibles, 3 broken ascending rami and condyles; 23 teeth, including 9 in crania, 8 in mandibles, and 6 isolated; 19 incomplete and complete ribs; 1 distal end of a humerus, broken about midshaft; 2 incomplete radii, 1 proximal end broken about midshaft, and 1 complete except for the distal, unfused epiphysis; 1 fragmentary ulnae; 8 incomplete pelves; 7 femora, 1 complete shaft with both epiphyses unfused, 3 unfused femur heads, 2 distal epiphyses, 1 proximal end with unfused epiphyses broken about midshaft; 3 complete patellae; 1 framentary fibula; 1 complete calcaneum; 1 complete astragulus; 3 incomplete and complete metapodials; 12 phalanges; plus numerous foot bones, including 1 complete trapezium, 1 complete lunar, 1 partial scaphoid, 2 complete uniforms, and 2 complete cuniforms. Also in the collection are 34 unidentifiable fragments. Identification was from Olsen's (1972) work on mammoths and mastodons.

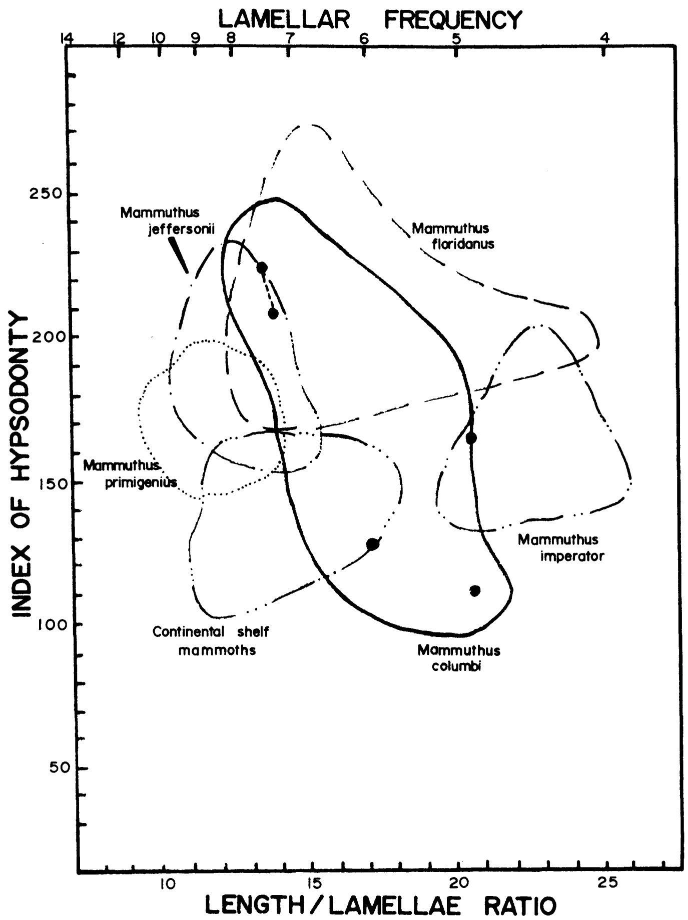

Figure 2. Variation in Hyposodonty and Lamellae Compression of first molars referred to as *Mammuthus columbi* from Hot Springs Mammoth Site, South Dakota (after Cooke, 1960, and in Whitmore *et al.*, 1967, and Saunders, 1970).

The elements from the "articulated" mammoth in Area A are not included in these statistics, as the additional 39 specimens remain *in situ.* Included in this study are specimens from the upper portion of Area B with a total known thickness of over 16 feet of thinly laminated fill.

As stated previously, searching the literature provided no standardized post-cranial measurements for mammoth. An attempt was then made to locate the most diagnostic measurements of each bone. After defining what I felt to be the most valuable, I noted what Jeffrey J. Saunders (personal communication, 1976) uses for the mastodon. Combining this with Maccagno's (1962) measurements for the mastodon and my own, I derived what I felt to be the diagnostic measurements for the mammoth. In an attempt to standardize the measurements, selected diagrams are included showing the measurements taken (Figs. 3 and 4).

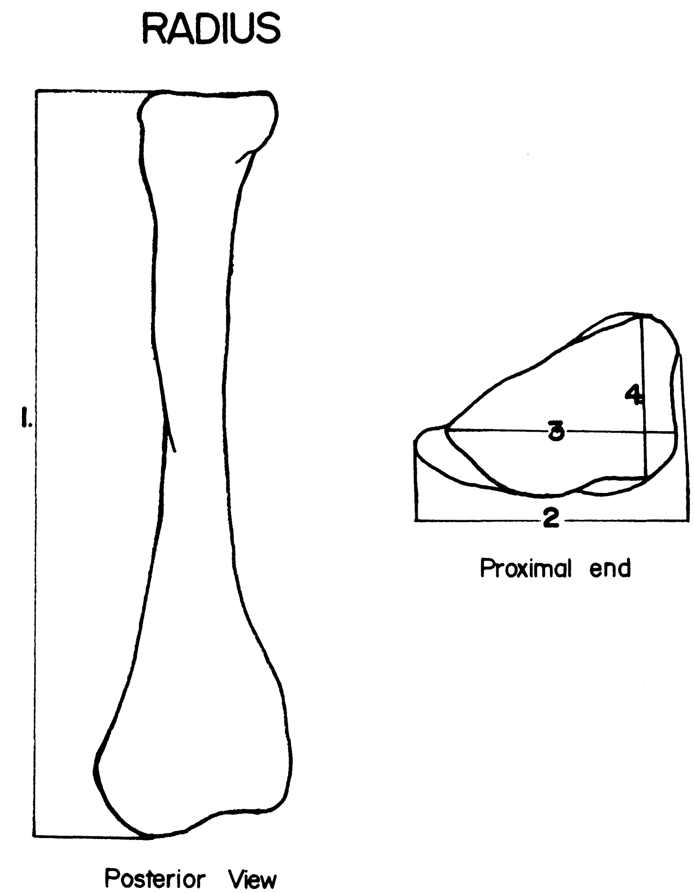

Figure 3. Measurements for the Radius: 1. Max. art. length, 2. Max. trans. dia. prox. end, 3. Max. trans. dia. art. surface (prox. end), 4. Ant. post. dia. art. surface (prox. end), 5. Breadth of carpal extremity.

Published comparative data are nearly non-existent with the exception of Osborn's (1942) data for *Parelephas jeffersoni* and a few *M. columbi.* measurements. The other published data are those of Saunders' (1970) on Arizona Columbian mammoth. From his 78 specimens recorded, only 10 were post-cranial remains. Barbour (1925) has the only published data on *Elephas columbi* from Nebraska. These comparative results must be considered with caution, as there is no indication as to the age of the individual. Measurements do reflect the age and maturity of the individuals. If ratios are used, more valid comparisons could be made (Table I).

SUMMARY AND CONCLUSIONS

I would like to stress that this is a preliminary paper and should be considered as a working report. Comparative data are nearly non-existent for post-cranial elements of the

Table I:

Comparative Measurements of *Mammuthus columbi*

Specimen	*E. columbi* Nb. St. Mus.	*P. columbi* Amherst Mus. 25-1	*M. columbi* Arizona	*M. columbi* So. Dakota
ATLAS				
Max. height	240	------	185-246	------
Wd. across trans. proc.	------	------	323-420	------
Ht. neural canal	110	------	90-142	------
Wd. neural canal	97	------	60-94	------
AXIS				
Trans. dia. centrum	180-280	------	215	191
Max. ht.	336	------	202	------
Ht. neural canal	75	------	62	------
Wd. neural canal	84	------	70	------
CERVICAL				
Trans. dia. centrum	192	------	154	203
Max. height	------	------	210	------
Ht. neural canal	58-70	------	64	70
Wd. neural canal	109-122	------	70	56
LUMBAR				
Trans. dia. centrum	135	------	------	126-160
THORACIC				
Trans. dia. centrum	144-156	------	------	131-153
SCAPULA				
Ht. supra-scap. border to glenoid	1257	1037	------	850-876
Lgt. of glenoid cavity	330	------	188-263	235-254
Wd. md. pt. length	------	------	113	468-594
HUMERUS				
Art. length	1226	1030	------	------
RADIUS				
Art. length	----	952	------	(709)
ULNA				
Art. length	1080	1060	------	------
FEMUR				
Art. length	------	1340	1300	(1008)
Mid. dia. trans.	157	------	------	161
Max. dia. head	------	------	180	141
TIBIA				
Art. length	-----	825	730	------

Columbian mammoth. With the coming field season, we hope to increase greatly our inventory of faunal remains and comparative data.

This should result in a complete representative sample of a local mammoth population and may give us an age structure as well as a statistical sample. The purpose of this paper is to standardize measurements of post-cranial elements of mammoth and to make the methodology known and available.

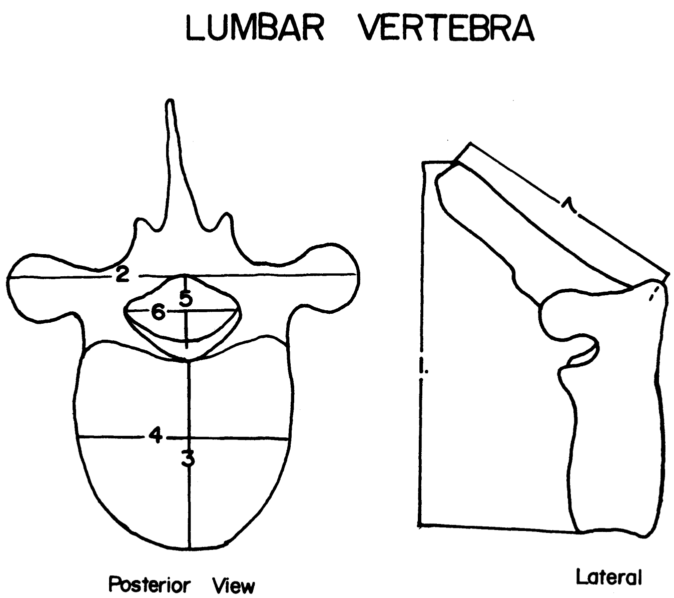

Figure 4. Measurements for the Lumbar Vertebra: 1. Max. height, 2. Max. width, 3. Max. height of centrum, 4. Max. width of centrum, 5. Max. height of neural canal, 6. Max. width of neural canal, 7. Height of spinous process.

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